WHAT IS CLAIMED IS:

1. A flow-through fluid analysis system for detecting an analyte in a fluid flow, comprising:

a sensor array having a first face and a second face, the sensor array including one or more first sensors and one or more fluid channels extending from the first face to the second face, at least one of the first sensors being located at a first position in the sensor array in contact with the first face of the sensor array, the one or more first sensors being configured to generate a response upon exposure of the sensor array to at least one analyte in a fluid flow;

a fluid flow system for introducing a fluid flow containing an analyte to the sensor array, such that upon introduction of a fluid flow to the sensor array a pressure differential is created between the first and second faces of the sensor array; and

a processor configured to receive the response generated by the one or more first sensors and to process the response to detect at least one analyte in a fluid flow.

2. The system of claim 1, wherein:

the sensor array includes a substrate having a first surface and a second surface; and

the fluid channels extend from the first surface to the second surface.

3. The system of claim 2, wherein:

the fluid channels include a plurality of pores in a microporous substrate material.

4. The system of claim 2, wherein:

the fluid channels include a plurality of holes introduced into an impermeable substrate material.

5. The system of claim 4, wherein:

the fluid flow system includes a predetermined sampling volume,

the sensor array is located within the sampling volume,

and the first sensor has a sensor volume, the sensor volume being substantially optimized to cause the first sensor to generate a response having a maximum signal to noise ratio for at least one target analyte.

6. The system of claim 5, wherein:

the sensor volume is substantially optimized as a function of a partition coefficient K of at least one target analyte.

7. The system of claim 6, wherein:

the predetermined sampling volume includes a headspace proximate to the first sensor, the headspace having a headspace volume $\mathcal{V}_h$; and

the sensor volume $\mathcal{V}_p$ is substantially optimized based on the function $\mathcal{V}_p = \mathcal{V}_h/K$.

8. The system of claim 1, wherein:

the one or more first sensors include a vapor sensor for detecting an analyte in a gas.

9. The system of claim 8, wherein:

the one or more first sensors include a plurality of vapor sensors for detecting an analyte in a gas.

10. The system of claim 1, wherein:

the one or more first sensors include a liquid sensor for detecting an analyte in a liquid.

11. The system of claim 10, wherein:

the one or more first sensors include a plurality of liquid sensors for detecting an analyte in a liquid.

12. The system of claim 1, wherein:

the sensor array includes at least one second sensor located at a second position in the sensor array, the second position being different from the first position relative to the fluid flow, the first and second sensors each generating a response upon exposure of the sensor array to at least one analyte in a fluid flow, such that the responses generated upon exposure of the sensor array to at least one analyte in a fluid flow include a spatio-temporal difference between the responses for the first and second sensors.

13. The system of claim 12, wherein:

the processor is configured to resolve a plurality of analytes in a fluid flow upon exposure of the sensor array to a fluid flow containing the plurality of analytes.

14. The system of claim 1, wherein:

the sensor array includes a plurality of second sensors, each of the first sensor and a plurality of the second sensors being located at a different position in the sensor array relative to the fluid flow, the first and second sensors each generating a response upon exposure of the sensor array to at least one analyte in a fluid flow, such that the responses generated upon exposure of the sensor array to at least one analyte in a fluid flow include a spatio-temporal difference between the responses for the first and second sensors.

15. The system of claim 1, wherein:

the sensor array includes a first substrate forming a plate having a length, a width, and a depth, such that the length and the width in combination define a pair of substrate faces and the width and the depth in combination define a pair of substrate edges, the first substrate being oriented in the sampling volume such that the substrate faces extend in a direction parallel to a direction of the fluid flow and the substrate edges are situated normal to the fluid flow; and

the one or more first sensor are located on one of the pair of substrate edges.

16. The system of claim 15, wherein:

the sensor array includes one or more second sensors located on one of the pair of substrate faces.

17. The system of claim 14, wherein:

the processor is configured to resolve a plurality of analytes in a fluid flow upon exposure of the sensor array to a fluid flow containing the plurality of analytes.

18. The system of claim 15, wherein:

the sensor array includes a plurality of second sensors located at different positions along one of the pair of substrate faces, such that the responses generated upon exposure of the sensor array to at least one analyte in a fluid flow include a spatio-temporal difference between responses generated by each of the first and the plurality of the second sensors.

19. The system of claim 16, wherein:

the sensor array includes a plurality of substrates, each substrate forming a plate having a length, a width, and a depth, such that for each of the substrates the length and the width in combination define a pair of substrate faces and the width and the depth in combination define a pair of substrate edges, the substrates being oriented in the sampling volume such that the substrate faces extend in a direction parallel to a direction of the fluid flow and the substrate edges are situated normal to the fluid flow; and

for each of the plurality of substrates, the sensor array includes one or more first sensors located on one of the pair of substrate edges and one or more second sensors located on at least one of the pair of substrate faces.

20. The system of claim 16, wherein:

at least one of the first sensor or the second sensors has a sensor volume, the sensor volume being substantially optimized to achieve a maximum signal to noise ratio for at least one target analyte.

21. The system of claim 20, wherein:

the sensor volume is substantially optimized as a function of a partition coefficient K of at least one target analyte.

22. The system of claim 21, wherein:

the predetermined sampling volume includes a headspace proximate to the first sensor, the headspace having a headspace volume $\mathcal{V}_h$; and

the sensor volume $\mathcal{V}_p$ is substantially optimized based on the function $\mathcal{V}_p = \mathcal{V}_h/K$.

23. The system of claim 15, wherein:

the one or more first sensors include a vapor sensor for detecting an analyte in a gas.

24. The system of claim 23, wherein:

the one or more first sensors include a plurality of vapor sensors for detecting an analyte in a gas.

25. The system of claim 15, wherein:

the one or more first sensors include a liquid sensor for detecting an analyte in a liquid.

26. The system of claim 25, wherein:

the one or more first sensors include a plurality of liquid sensors for detecting an analyte in a liquid.

27. A method of detecting an analyte in a fluid flow, comprising:

providing a sensor array having a first face and a second face, the sensor array including one or more first sensors and one or more fluid channels extending from the first face to the second face, at least one of the first sensors being located at a first position in the sensor array in contact with the first face of the sensor array, the one or more first sensors being configured to generate a response upon exposure of the sensor array to at least one analyte in a fluid flow;

exposing the sensor array to a fluid flow including an analyte under conditions sufficient to create a pressure differential between the first and second faces of the sensor array;

measuring a response for the one or more first sensors; and

detecting the presence of the analyte in the fluid based on the measured response.

28. The method of claim 27, wherein:

the sensor array includes a substrate having a first surface and a second surface; and

the fluid channels extend from the first surface to the second surface.

29. The method of claim 28, wherein:

the fluid channels include a plurality of pores in a microporous substrate material.

30. The method of claim 28, wherein:

the fluid channels include a plurality of holes introduced into an impermeable substrate material.

31. The method of claim 30, wherein:

the first sensor has a sensor volume, the sensor volume being substantially optimized to cause the first sensor to generate a response having a maximum signal to noise ratio for at least one target analyte.

32. The method of claim 31, wherein:

the sensor volume is substantially optimized as a function of a partition coefficient K of at least one target analyte.

33. The method of claim 32, wherein:

the predetermined sampling volume includes a headspace proximate to the first sensor, the headspace having a headspace volume $\mathcal{V}_h$; and

the sensor volume $\mathcal{V}_p$ is substantially optimized based on the function $\mathcal{V}_p = \mathcal{V}_h/K$.

34. The method of claim 27, wherein:

the one or more first sensors include a vapor sensor for detecting an analyte in a gas.

35. The method of claim 34, wherein:

the one or more first sensors include a plurality of vapor sensors for detecting an analyte in a gas.

36. The method of claim 27, wherein:

the one or more first sensors include a liquid sensor for detecting an analyte in a liquid.

37. The method of claim 36, wherein:

the one or more first sensors include a plurality of liquid sensors for detecting an analyte in a liquid.

38. The method of claim 27, wherein:

the sensor array includes at least one second sensor located at a second position in the sensor array, the second position being different from the first position relative to the fluid flow, the first and second sensors each generating a response upon exposure of the sensor array to at least one analyte in a fluid flow, such that the responses generated upon exposure of the sensor array to at least one analyte in a fluid flow include a spatio-temporal difference between the responses for the first and second sensors.

39. The method of claim 38, wherein:

detecting the presence of the analyte in the fluid includes resolving a plurality of analytes in the fluid based on the measured response .

40. The method of claim 27, wherein:

the sensor array includes a plurality of second sensors, each of the first sensor and a plurality of the second sensors being located at a different position in the sensor array relative to the fluid flow, the first and second sensors each generating a response upon exposure of the sensor array to at least one analyte in a fluid flow, such that the responses generated upon exposure of the sensor array to at least one analyte in a fluid flow include a spatio-temporal difference between the responses for the first and second sensors.

41. The method of claim 27, wherein:

the sensor array includes a first substrate forming a plate having a length, a width, and a depth, such that the length and the width in combination define a pair of substrate faces and the width and the depth in combination define a pair of substrate edges, the first substrate being oriented in the sampling volume such that the substrate faces extend in a direction parallel to a direction of the fluid flow and the substrate edges are situated normal to the fluid flow; and

the one or more first sensor are located on one of the pair of substrate edges.

42. The method of claim 41, wherein:

the sensor array includes one or more second sensors located on one of the pair of substrate faces.

43. The method of claim 40, wherein:

detecting the presence of the analyte in the fluid includes resolving a plurality of analytes in the fluid based on the measured response .

44. The method of claim 41, wherein:

the sensor array includes a plurality of second sensors located at different positions along one of the pair of substrate faces, such that the responses generated upon exposure of the sensor array to at least one analyte in a fluid flow include a spatio-temporal difference between responses generated by each of the first and the plurality of the second sensors.

45. The method of claim 42, wherein:

the sensor array includes a plurality of substrates, each substrate forming a plate having a length, a width, and a depth, such that for each of the substrates the length and the width in combination define a pair of substrate faces and the width and the depth in combination define a pair of substrate edges, the substrates being oriented in the sampling volume such that the substrate faces extend in a direction parallel to a direction of the fluid flow and the substrate edges are situated normal to the fluid flow; and

for each of the plurality of substrates, the sensor array includes one or more first sensors located on one of the pair of substrate edges and one or more second sensors located on at least one of the pair of substrate faces.

46. The method of claim 42, wherein:

at least one of the first sensor or the second sensors has a sensor volume, the sensor volume being optimized to achieve a maximum signal to noise ratio for at least one target analyte.

47. The method of claim 46, wherein:

the sensor volume is optimized as a function of a partition coefficient *K* of at least one target analyte.

48. The method of claim 47, wherein:

the predetermined sampling volume includes a headspace proximate to the first sensor, the headspace having a headspace volume $\mathcal{V}_h$; and

the sensor volume $\mathcal{V}_p$ is optimized based on the function $\mathcal{V}_p = \mathcal{V}_h / K$.

49. The method of claim 41, wherein:

the one or more first sensors include a vapor sensor for detecting an analyte in a gas.

50. The method of claim 49, wherein:

the one or more first sensors include a plurality of vapor sensors for detecting an analyte in a gas.

51. The method of claim 41, wherein:

the one or more first sensors include a liquid sensor for detecting an analyte in a liquid.

52. The method of claim 51, wherein:

the one or more first sensors include a plurality of liquid sensors for detecting an analyte in a liquid.

53. A sensor array for detecting an analyte in a fluid, comprising:

one or more substrates, each substrate having a first surface;

one or more sensors in contact with the substrates, the sensors being configured to generate a response upon exposure of the sensor array to at least one analyte in a fluid, each sensor having a sensor volume, the sensor volume for at least one of the sensors being substantially optimized to cause the first sensor to generate an optimized response upon exposure of the sensor array to at least one target analyte.

54. The sensor array of claim 53, wherein:

the sensor volume is substantially optimized as a function of a sampling headspace volume $\mathcal{V}_h$ and a partition coefficient K of at least one target analyte.

55. The sensor array of claim 54, wherein:

the sensor volume $\mathcal{V}_p$ is substantially optimized based on the function $\mathcal{V}_p = \mathcal{V}_h / K$.

56. The sensor array of claim 53, wherein:

the one or more sensors include two or more optimized sensors, each of the optimized sensors being substantially optimized to generate an optimized response upon exposure of the sensor array to a different target analyte.

57. The sensor array of claim 53, wherein:

the optimized response has a substantially maximized signal to noise ratio.

58. A sensor array for detecting an analyte in a fluid flow, comprising:

a substrate having a first surface and a second surface;

one or more sensors in contact with the first surface, the one or more sensors being configured to generate a response upon exposure of the sensor array to at least one analyte in a fluid flow; and

one or more fluid channels extending from the first surface to the second surface.

59. The sensor array of claim 58, wherein:

the fluid channels are configured such that upon introduction of a fluid flow to the sensor array a pressure differential is created between the first and second surfaces of the substrate.

60. The sensor array of claim 58, wherein:

the substrate includes a microporous material; and

the fluid channels include a plurality of pores in the substrate.

61. The sensor array of claim 58, wherein:

the substrate includes an impermeable material; and

the fluid channels include a plurality of holes introduced into the substrate.

62. The sensor array of claim 58, wherein:

the one or more sensors include a vapor sensor for detecting an analyte in a gas.

63. The sensor array of claim 62, wherein:

the one or more sensors include a plurality of vapor sensors for detecting an analyte in a gas.

64. The sensor array of claim 58, wherein:

the one or more sensors include a liquid sensor for detecting an analyte in a liquid.

65. The sensor array of claim 64, wherein:

the one or more sensors include a plurality of liquid sensors for detecting an analyte in a liquid.

66. A sensor array for detecting an analyte in a fluid flow, the sensor array having a first face and a second face, the sensor array comprising:

one or more substrates, each substrate forming a plate having a length, a width, and a depth, such that the length and the width in combination define a pair of substrate faces and the width and the depth in combination define a first substrate edge and a second substrate edge, the first substrate edge for each of the substrates being aligned with the first face of the array;

a plurality of sensors configured to generate a response upon exposure of the sensor array to at least one analyte in a fluid flow, the sensors including one or more first sensors sensors, each of the first sensors being located along one of the first substrate edges, the sensors also including one or more second sensors, each of the second sensors being located along one of the substrate faces; and

one or more fluid channels extending along one or more of the substrate faces from the first face of the array to the second face of the array.

67. The sensor array of claim 66, wherein:

the plurality of sensors includes a plurality of second sensors located at different positions along at least one of the pair of substrate faces, such that the responses generated upon exposure of the sensor array to at least one analyte in a fluid flow include a spatio-temporal difference between responses generated by each of the first and the plurality of the second sensors.

68. The sensor array of claim 66, wherein:

the sensors include a vapor sensor for detecting an analyte in a gas.

69. The sensor array of claim 68, wherein:

the sensors include a plurality of vapor sensors for detecting an analyte in a gas.

70. The sensor array of claim 66, wherein:

the sensors include a liquid sensor for detecting an analyte in a liquid.

71. The sensor array of claim 70, wherein:

the sensors include a plurality of liquid sensors for detecting an analyte in a liquid.

72. A method of fabricating a sensor array for detecting an analyte in a fluid, comprising:

providing a substrate having a surface and a sampling headspace proximate to the surface;

identifying a sampling headspace volume $\mathcal{V}$ for at least a portion of the sampling headspace, and a partition coefficient K of at least one target analyte in a sensing material;

calculating a sensor volume based on the sampling headspace volume and the partition coefficient; and

fabricating a sensor on the surface proximate to the at least a portion of the sampling headspace, the sensor including an amount of the sensing material derived from the calculated sensor volume.

73. The method of claim 72, wherein:

the sensor volume $\mathcal{V}_p$ is calculated based on the function $\mathcal{V}_p = \mathcal{V}_t / K$.